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INDUSTRIAL SAFETY TRAINING AT A MINING SCHOOL

BY

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INDUSTRIAL SAFETY TRAINING AT A MINING SCHOOL[1]

By E. H. Denny[2] and G. M. Kintz[3]

Although some engineering colleges recognize the importance of instructing young engineers in industrial safety, the different institutions handle this instruction in various ways. It is believed that a recent industrial safety course, conducted at the Colorado School of Mines through the cooperation of this school and the Bureau of Mines, U. S. Department of Commerce, presents some unusual features that are of interest to other schools and to the mining public.

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DESCRIPTION OF COURSE

The industrial safety course at the Colorado School of Mines, Golden, Colo., covered a 2-week period during the spring of 1930 and was supplementary to any discussion of and reference to safety incident to any of the other school courses. One-half of the junior and senior students took this industrial safety course; taking one-half of the upper-class men thus each year while the other half are completing required field trips insures that all graduating students will have some realization of the importance and principles of safety.

The men enrolled for the industrial safety course included students of mining, petroleum engineering, geology, metallurgy, and geophysics. Any lectures given, therefore, to the entire group had to be general enough to be of value to all, it being borne in mind also that the graduating students might eventually engage in other lines of engineering work than that indicated by their graduating degrees. The preponderance of mining and petroleum students in the group seemed, however, to justify special attention to mining and oil safety.

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After some study of this situation by the school authorities and the authors of this paper the following plan was agreed upon:

1. Emphasis should be placed during all safety lectures and discussions upon the economic importance of safety in industry.

2. The course should consist of: (1) six general safety lectures of two hours each to be attended by all students enrolled; (2) five petroleum safety lectures of two hours each; (3) five evening lectures and practice periods in first aid to the injured - to be attended by all of the enrolled students but classes to be split in half for better work and the students required to attend on alternate nights for a 10-day period; and (4) five morning or afternoon classes of four hours each for the mining students in the study and use of mine rescue apparatus and accessories and in principles of mine rescue and mine fire-fighting work. Inasmuch as only 10 students could be handled in a class on account of the 10 mine-rescue apparatus available the approximately 30 mining students had to be divided into three groups working on different days.

3. Typewritten notes were required to be handed in on all general safety and petroleum-safety lectures. It was also required that one article on safety be read and briefly abstracted with each lecture, a number of publications of the Bureau of Mines, periodicals, and safety rules of companies, and publications of the National Safety Council to be made available in the school library for this purpose.

4. Five safety engineers from several Denver industries gave lectures on the various phases of industrial safety with which they were particularly familiar.

The courses as conducted in accordance with the above plan were scheduled as follow:

SCHEDULE - INDUSTRIAL SAFETY CLASSES

	A.M. 8 to 12 Experimental Plant	A.M. 9 to 11 Straton Hall	P.M. 1 to 5 Experimental Plant	P.M. 7 Straton Hall
Monday		General Safety	Mine Rescue (a)	First Aid (a)
Tuesday	Mine Rescue (b)	Petroleum Safety	Mine Rescue (c)	First Aid (b)
Wed.		General Safety	Mine Rescue (a)	First Aid (a)
Thurs.	Mine Rescue (b)	Petroleum Safety	Mine Rescue (c)	First Aid (b)
Friday		General Safety	Mine Rescue (a)	First Aid (a)
Sat.	Mine Rescue (b)	Petroleum Safety		
Monday		General Safety	Mine Rescue (c)	First Aid (b)
Tuesday	Mine Rescue (b)	Petroleum Safety	Mine Rescue (a)	First Aid (a)
Wed.		General Safety	Mine Rescue (c)	First Aid (b)
Thurs.	Mine Rescue (b)	Petroleum Safety	Mine Rescue (a)	First Aid (a)
Friday		General Safety	Mine Rescue (c)	First Aid (b)

FIRST-AID COURSE

The first-aid course for all students is the same course as that given by the Bureau of Mines during the fiscal year 1930 to more than 112,000 persons in the mining and petroleum industries and has been given to all upper classmen annually at the Colorado School of Mines for a number of years. In five evening lessons the control of bleeding, artificial resuscitation, the bandaging of wounds, the splinting of fractures, and the treatment of shock are taught through lecture, demonstration, and actual application of bandages and splints by class members. It is considered that such first-aid training not only promotes the saving of life and minimizing of injury by prompt and effective treatment of an injured person when an accident occurs, but also tends to prevent accidents through the predisposition of a person trained in first aid to think and to act safely.

MINE RESCUE COURSE

The mine rescue course given to 30 mining students was also a standard course of the Bureau of Mines. The students were required to wear self-contained oxygen breathing apparatus and perform work in irrespirable gases; and they studied the construction and operation of this apparatus, and the limitations of its use. They also studied organization and methods for combatting mine fires and for mine recovery after an explosion or a fire. The underground work was performed in some drifts driven some years ago by students in a hillside near Golden.

GENERAL SAFETY COURSE

The lectures in the general safety course covered briefly the subjects listed below and a large optional list of references furnished additional information. The reading and abstracting of portions of any six of these references were required.

OUTLINE OF GENERAL SAFETY COURSE

First Lecture:

Importance of safety to the nation and the individual.
The purpose of the United States Bureau of Mines; details of its work toward safety and efficiency in the mineral industries.
Accident statistics.
- (a) by whom compiled and where available.
- (b) frequency and severity bases.
- (c) lost time accidents, fatalities, permanent disabilities, non-injury accidents.
- (d) comparative accident experience of various industries.

Economic losses in industry due to accidents.
- (a) over $2,000,000,000 annual loss to employer, employee, and public through accidents.
- (b) direct and indirect costs of accidents to employers.

Compensation laws.
Comparison of mine accident rates in the United States and Europe.
Organization - purpose and description of various company safety organizations.
Safety education of officials and employees.
Discipline.
Safety records of companies having good safety records showing financial saving to companies.

Second Lecture:

Electrical safety (by officials of an electric company)
- (a) handling of disconnecting switches.
- (b) the installation and removal of station grounds.
- (c) safety practice in servicing a line.
- (d) fuses.
- (e) electrical fire extinguishment.
- (f) types of men desirable for electrical work.
- (g) types of insulating material.
- (h) tests of insulating material for safety.
- (i) precautions in the use and storage of rubber insulating material.

Third Lecture:

Mine and industrial gases.

Normal air.
Oxygen - Properties and physiological effects.
Nitrogen - Properties, physiological effects and detection.

Carbon dioxide - Properties, physiological effects and detection.
Hydrogen sulphide - Properties, physiological effects and detection.
Carbon monoxide - Properties, physiological effects and detection.
Methane - Properties, physiological effects, and detection.
Oxides of Nitrogen - Properties, physiological effects and detection.
Showing of gas detectors.
Discussion of gas occurrences in mines and in caisson work.

Fourth Lecture:

Safety in the use of explosives (by an explosives engineer of an explosives company).
Low-freezing explosives.
How to thaw explosives.
"Don'ts" in handling explosives.
Storage of explosives.
Permissible explosives.
Use of explosives in quarries.
Use of explosives in mines.
Motion pictures on use of explosives.

Fifth Lecture:

Humidity and its relation to safety and efficiency when accompanied by high temperatures.
Mine ventilation.
Gasoline vapor.
Protection against gases.
- (a) hose mask, use and limitations.
- (b) gas mask, use and limitations.
- (c) oxygen breathing apparatus, use and limitations.

Showing of masks and oxygen apparatus.
Mine accidents.
- (a) accidents from falls of rock, roof, coal, ore, and methods for their avoidance.
  discussion of and lessons from various mine explosions.

Permissible electrical equipment.
Mine lighting - permissible electric lamps.
Safe clothing (hats, shoes, goggles, etc.)

Sixth Lecture:

- Mechanical safeguards.
  - Importance and principles of belts and pulleys.
- Ladders.
- Safety in the use of hand tools.
- Safety in the use of jacks.
- Fire and prevention extinguishment.
  - (a) fire extinguishers.
  - (b) automatic sprinkling systems.
  - (c) fire hose and hydrants.
  - (d) chemical engines.
- Underground fires.
  - (a) importance of organization and equipment.
  - (b) sealing of fires in gassy mines.
- Conclusion - desire of U. S. Bureau of Mines to cooperate with the mining industry.

PETROLEUM SAFETY COURSE

The petroleum safety course was given to some 30 students in petroleum engineering. The course included some subjects touched upon in the general safety course which were considered in much more detail in the petroleum course. An outline of the lectures given is as follows:

First Lecture:

- Gases found in the petroleum industry.
  - Normal air.
  - Oxygen.
    - (a) effects of oxygen deficiency.
    - (b) extinguishment of various flames by oxygen deficiency.
  - Nitrogen.
  - Carbon dioxide.
    - (a) effect on man.
    - (b) determination of carbon dioxide with Orsat apparatus.
  - Helium.
  - Petroleum and gasoline vapors.
    - (a) properties.
    - (b) detection of combustible gases and protection against them.
    - (c) protection against oil vapors.
    - (d) treatment for poisoning by petroleum and gasoline vapors.
  - Hydrogen sulphide.
    - (a) properties and physiological effects.
    - (b) treatment of hydrogen sulphide poisoning.
    - (c) detection of hydrogen sulphide.
    - (d) protection against hydrogen sulphide.

Carbon monoxide.
- (a) detection and types of detectors.

Second Lecture:

Sulphur dioxide.
- (a) properties and physiological effects.
- (b) treatment of sulphur dioxide poisoning.
- (c) protection against sulphur dioxide.

Chlorine.
- (a) properties and physiological effects.
- (b) treatment of chlorine poisoning.
- (c) safe handling of chlorine tanks.
- (d) protection against chlorine.

Natural gas (by an official of a gas company).
- (a) general rules for handling.
- (b) "bagging off" of openings in mains.
- (c) properties of natural gas.
- (d) the gas detector - demonstration and principles.
- (e) rules when working in manholes.
- (f) protection in excavations.
- (g) repair work on private property.
- (h) safety appliances in use of gas in homes.

Third Lecture:

Oxides of nitrogen.
- (a) properties and physiological effects, also occurrence.
- (b) protection against.

Carbon tetrachloride.
- (a) dangers of, when used on a fire in confined spaces.

Types of combustible gas detectors.
- (a) flame safety lamp - demonstration.
- (b) "Burrell" methane detector - demonstration.
- (c) "Martienssen" methane detector.
- (d) "J. W." methane detector.
- (e) "Jones" methane detector.
- (f) detector.

Sampling of gases.

Protection against gases.
- (a) hose mask with blower.
- (b) types of gas mask canisters.
- (c) limitations of gas masks.

Fourth Lecture:

Safe practice in pulling wells.
- (a) inspection.
- (b) precautions in work.

Lighting.
- (a) importance of good illumination.
- (b) dangers of various types of lighting.

Fire protection and extinguishment (by a representative of a fire extinguisher company).
- (a) essentials of fire protection.
- (b) types of fire extinguishers.
- (c) principles and action of foam extinguishers.

Fifth Lecture:

Oil fires.

Causes.

Fighting oil fires.
- (a) tank fires.
- (b) rig fires.

Cleaning oil tanks.

Precautions in entering tanks.

Precautions with electrical equipment about tanks and refineries.

Types of switches, motors, and lights, to use.
Conduit wiring .
Grounding of electrical equipment.
Tank-gaging precautions.
Static electricity hazards.

PUBLICATIONS FOR STUDY WITH SAFETY COURSE

Each student was required to read and abstract portions of any six of certain assigned publications in the general safety course and of any five of certain assigned publications in the petroleum safety course. Lists of these publications follow:

Publications for Reference in General Safety Course:

Annual Report of the Director of the Bureau of Mines for the year ending June 30, 1929.- Summary of general fields of work.

Bulletin 310 - U. S. Bureau of Mines - Metal Mine Accidents in the U. S. 1927 - Causes of Accidents page 2, Method of estimating lost time from accidents pages 57-58, accidents in mineral industries frequency rates page 91.

Workmen's compensation act of Colorado - pages 20 - 35 section 50 to section 88.

Bulletin 293 - U. S. Bureau of Mines - Coal Mine Fatalities in the United States: 1927 - Defects of tonnage basis for accident statistics - bottom page 1 to page 2 inclusive.

Circular 6166 - U. S. Bureau of Mines - Accident Cost and Mine Safety.

Circular 6045 - U. S. Bureau of Mines - Coal Mine Safety Organization.

Practical Accident Prevention - J. R. Davis - U. S. Gypsum Company.

Miners' Circular 33 - U. S. Bureau of Mines - Mine Gases and Methods for Their Detection.

Technical Paper 373 - U. S. Bureau of Mines - The Pyrotannic Acid Method for the Quantitative Determination of Carbon Monoxide in Blood and in Air.

Gases which occur in Metal Mines. - A.I.M.E. Reprint.

Miners' Circular 35 - U. S. Bureau of Mines - Protection Against Gases Encountered in Mines

Serial 2847 - U. S. Bureau of Mines "Prevention of Hydrogen Sulphide Poisoning in Handling and Refining High Sulphur Petroleums" pages 13 to 15 inclusive.

Serial 2865 - U. S. Bureau of Mines - Rock Strata Gases in the Cripple Creek District and Their Effect on Mining.

Serial 2944 - U. S. Bureau of Mines - Accidents in Metal Mines Due to Falls of Men and Material.

Information Circular 6225 - U. S. Bureau of Mines - Reducing Accidents from Falls of Roof in Coal Mines.

Information Circular 6242 - Safety in Utah Coal Mines as Affected by Haulage.

Information Circular 6243 - Safety in Connection with Haulage Practices in Alabama Coal Mines.

Technical Paper 464 - U. S. Bureau of Mines - Coal Dust Explosibility Factors Indicated by Experimental Mine Investigations 1911 - 1929.

Report of Investigations 2977 - U. S. Bureau of Mines - Rock Dust Barriers for Coal Mines.

State of Oklahoma, Department of Labor, Bureau of Factory Inspection, Bulletin No. 11-A - Petroleum Industry Safety Standards pages 3, 4, pages 7 to 14.

Public Service Company of Colorado - Safety Manual 1929.

Paper Delivered before Denver Colorado Safety Council by U. S. Bureau of Mines Employee entitled Danger to the Public from Carbon Monoxide.

National Safety News October 1929 article entitled Metal Mines Need Good Ventilation.

Information Circular 6073 - U. S. Bureau of Mines - Fires and Fire Prevention in the Lake Superior Mines.

Information Circular 6076 - U. S. Bureau of Mines - How Fires Start in Mines.

Bulletin 188 - U. S. Bureau of Mines - Lessons from the Granite Mountain Shaft Fire, Butte.

Public Health Bulletin 186 - Effect of Repeated Daily Exposure of Several Hours to Small Amounts of Automobile Exhaust Gas.

Technical Paper 355 - U. S. Bureau of Mines - A Carbon Monoxide Recorder and Alarm.

Safe Practices Pamphlet No. 29 - National Safety Council - Electrical Equipment in Industrial Plants.

Safe Practices Pamphlet No. 74 - National Safety Council - Competition as an Aid in Promoting Accident Prevention.

Safe Practices Pamphlet 37 - National Safety Council - Industrial Ventilation.

Safe Practices Pamphlet No. 39
National Safety Council - Machine shop Machinery.

Miners' Circular 36,- U. S. Bureau of Mines - Suggested Procedure in Sealing and Unsealing Mine Fires and in Recovery Operations.

Publications for Reference with Petroleum Safety Course:

National Safety Council - Safe Practices Pamphlet No. 35 - Acids and Caustics.

Transactions Vol. II of the National Safety Council - 1927 - Petroleum Section. Pages 407 - 417.

1928 Transactions of the National Safety Council - Petroleum Sction - Pages 429 - 436. Pages 439-448.

U. S. Public Health Service Bulletin No. 163 - The Use of Tetraethyl Lead Gasoline in its Relation to Public Health. Pages 108-111, 117-123.

Industrial Engineering, Oct. 1929. Pages 495-498, 520-523.

Oil Bulletin, Feb. 1928, Pages 145-147, 203.

Oil Bulletin, Mar. 1928, Pages 256, 307.

Oil Bulletin, Apr. 1928, Pages 409-411.

Oil Bulletin, June 1928, Pages 581-585.

Oil Bulletin, Oct. 1928, Pages 1039-1045-1049.

Oil Bulletin, Nov. 1928, Pages 1155, 1161.

Oil Bulletin Dec. 1928, Page 1256.

Oil Bulletin, July 1929, Pages 685-709.

Bulletin 231 - U. S. Bureau of Mines - Investigations of Toxic Gases from Mexican and other High Sulphur Petroleums and Products.

Bulletin 305 -U. S. Bureau of Mines - Inspection and Testing of Mine Type Electrical Equipment for Permissibility. (Parts dealing with electrical equipment in gases).

Information Circular 6064-U. S. Bureau of Mines-Accident Prevention work of Midwest Refining Co.

Safety Rules and Instructions, Colorado Fuel and Iron Company, Minnequa Steel Works, Pages 17-21.

American Gas Association - Occupational Hazards of the Gas Industry.

CONCLUSION

Frequently it has been stated at various industrial operations that the graduate engineers given employment had little or no training along safety lines. This apparent lack of safety training is being remedied at some engineering schools, notably the Colorado School of Mines, by definite industrial safety courses required as a requisite to graduation.

It is felt that the importance of safety in industry can best be stressed to the undergraduate through continued insistence upon and demonstration of the economic importance of accident lessening and prevention.

The methods and procedure used in conducting the various safety classes at the Colorado School of Mines are subject to change to best meet the student needs; however, it is believed that any course in safety should emphasize from a cost standpoint the importance of safety education of officials and employees, the importance of discipline in lessening accidents, and the value of mechanical safeguards and a safety organization in preventing accidents. Also students should be trained in how properly to treat and care for injuries to themselves and others.